element with exosmosis. Curves representing the equation derived thus on theoretical grounds resemble in type those obtained in actual experiments. The methods used in this work seem admirably adapted to a crucial test of CZAPEK'S theory, which seems entirely untenable in view of the evidence submitted.—CHARLES A. SHULL.

Desiccation.—An investigation of the course of desiccation and partial starvation in cacti has been made by MACDOUGAL, LONG, and BROWN.[15] The principal studies center upon the changing rate of water loss, chemical changes in the food reserves, plasmatic colloids, and cell sap, and the morphological changes which occur during long periods of desiccation. In one case a large *Echinocactus* was under observation for 6 years after removal of the plant from the soil. Water loss is rather rapid at first, but proceeds more and more slowly with time. While 10 per cent of the water was lost the first year in one specimen, during the sixth year only 5 per cent of the water remaining at the beginning of that year was lost. The loss of water is much more rapid of course in the open than in diffuse light and *Echinocactus* can withstand desiccation not more than 2 years with free exposure.

The chief chemical changes noted during the starving period concern the carbohydrates. The density of the cell sap decreases, due to disintegration of the carbohydrates, and the reducing sugars are found mainly in the inner part of the cortex in desiccated specimens rather than near the surface as in normal plants. The total amount of reducing sugars decreases during desiccation, while non-reducing sugars are increased noticeably in the cell sap. Reduction of the amount of sugars leads to reduction of acidity if the light intensity is sufficient for photolysis of the acid. In weak light even, if the sugars run low, the acids may accumulate because of the absence of photolysis. Differences in acidity are thought to be partially responsible for differences in the colloid hydration and swelling of tissues when placed in water.

The main morphological changes consist in thickening of the cuticle, thinning of the anterior walls of the guard cells, partial destruction of the plasmatic colloids, shrinkage in the size of the nucleus, and especially the development of cortical lacunae through hydrolysis of the cell walls of this region of the stem. The vascular tissues are not affected, and the medullary cells much less than the cortical cells.—CHARLES A. SHULL.

The vegetation of Michigan.—From the data obtained during a few weeks in Michigan, HARPER[16] has listed the principal plants in the order of their abundance and has discussed certain features of the environment. He recognizes but two types of succession, the one from the filling up of lakes and other

[15] MACDOUGAL, D. T., LONG, E. R., and BROWN, J. G., End results of desiccation and respiration in succulent plants. Physiol. Res. 1:289–325. 1915.

[16] HARPER, R. M., The plant population of northern lower Michigan and its environment. Bull. Torr. Bot. Club **45**:23–42. 1918.

depressions, and the other that following fire. In connection with the former, he distinguishes the usually recognized types of marsh and bog vegetation and states that the main distinction between the two is in the rate of growth, the slow rate of growth in bog plants being largely explained upon the basis of a dearth of mineral plant food in the substratum, which is also supposed to account for the presence of the same species upon the uplands in colder climates. No experimental evidence is given in support of this explanation. It is also rather surprising to be told that bog vegetation is "sometimes erroneously called xerophytic," after the almost endless discussion of bog xerophytes.

A deficiency of mineral plant food is also given as an explanation of the slow progress toward mesophytism of the pine forests upon sandy uplands. Leaching is supposed to prevent the accumulation of any considerable amount of plant food near the surface of the ground. This may possibly hold for the sandy plains, but if so it is difficult to see why it should not also apply to the pure sand of the dunes, where mesophytic forests develop rather quickly and where the conifers are soon largely replaced by deciduous species.

In discussing the influence of fire upon forest establishment, the error is made of stating that the cones of *Pinus Banksiana* remain closed and attached to the tree for many years, opening and discharging their seed after burning. Closer observation would have shown that the cones that remain for several years upon this pine open and discharge their seed very promptly upon ripening, and that the tree is in no wise dependent upon fire for its seeding.—GEO. D. FULLER.

Fairy rings and their effect on vegetation.—Of more than ordinary interest is a recent paper on fairy rings by SHANTZ and PIEMEISEL.[17] Before taking up their own researches, they present an excellent summary of past studies and theories concerning them, as well as a table of the fungi that have been reported as being responsible for rings. Some fungi, as *Agaricus tabularis*, are very destructive to grass and other vegetation; some, as *Calvatia* and *Lycoperdon*, are beneficial; and some, as *Lepiota*, have little effect of any sort. Striking conclusions are given relative to the age of rings. The conditions in eastern Colorado are not very favorable, either for spore germination or mycelial advance; in favorable years there may be a mycelial advance from the ring center of 30–60 cm., as compared with almost no advance at all in dry years. Some of the rings are very large, and from the growth measurements that have been made, a few are estimated to be 400–600 years old. Where vegetation is stimulated, it was concluded from careful study that this is due to the reduction of nitrogenous organic matter to available nitrates and ammonia salts, and to the subsequent decay of the fungous filaments. Deterioration or death of vegetation are attributed mainly to drought, caused by the prevention of water

[17] SHANTZ, H. L., and PIEMEISEL, R. L., Fungous fairy rings in eastern Colorado and their effect on vegetation. Jour. Agric. Research 11:191–246. *pls. 21. figs. 15.* 1917.